

Telecommunications Study:
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services, etc. to include, but not be limited to present participation, numbers of firms, industry share, firm size, etc.

Task II

Define the minority business market share of the telecommunications industry to include at a minimum competition; barriers to firm entry; firm profile, i.e., employment, capital/labor ratio, firm capital composition, industry capital needs, etc.

The intent is to obtain an idea of MBE position and firm characteristics to aid in the assessment of MBE needs in the development of a MBDA program strategy.

Volume II addresses Task III of the four Tasks included in the Statement of Work (SOW). The SOW and the requirements for Task III are quoted as follows:

TASK III

Recommend MBE market penetration strategies to consist at a minimum of: product/industry target; market niche (product, price, distribution strategy); market segmentation issues; channels of distribution; revenue sources; firm capital needs; etc.

The intent here is to obtain information on alternative ways of assisting MBEs to survive in the telecommunications industry. To aid in the development of MBDA program strategies.

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MARKET SEGMENT ANALYSIS

CELLULAR RADIOTELEPHONE

I. MARKET DEFINITION

Cellular radiotelephone or cellular radio is a two-way communication technology which subdivides an area into small regions (cells), each served by a low power transmitter/receiver and antenna (base station) placed in a particular location (cell site). The base station of each cell is connected to a mobile telephone switching office (MTSO) by either conventional or microwave technology. The MTSO is a highly sophisticated computer which coordinates calls for an entire switching area and automatically routes calls to specific cell sites and provides interconnection with the worldwide public switched telephone network. Local, long distance, and international calling can be completed both to and from a cellular telephone without the intervention of an operator.

Every cell is allocated a set of frequencies, with neighboring cells assigned different frequencies to avoid interference. A frequency channel that carries a conversation in one cell can be used several cells away to carry another conversation. The ability to reuse frequencies and to maintain the strongest possible signal through a process known as "hand-off" have increased the number of subscribers that can be served in a given area. Although cellular technology was originally designed to address mobile voice communications, applications have been developed for fixed users and the transmission of data.

In 1981, the FCC created commercial cellular radio service by allocating 50 MHz of spectrum (824-849 MHz and 869-894 MHz) to be made available to two competing systems per market, each using 25 MHz. In each area, one license (25 MHz) was reserved for the local telephone company (wireline carrier), the other to a non-wireline company. Market or service areas were developed by the Bureau of the Census and consisted of 306 Metropolitan Statistical Areas (MSAs) and 428 Rural Service Areas (RSAs).

To date, all MSA licenses have been granted and are up and running. All 428 RSA construction permits have also been granted, but several are now expiring without a system in operation. Because of FCC "trafficking" rules, the expiring licenses cannot be transferred and will return to the FCC to be awarded to another applicant in the original lottery. FCC rules allow the sale of an

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up and running cellular system after an applicable holding period to either a wireline or non-wireline company, although no single firm can hold both licenses in a single market.

II. MARKET ENVIRONMENT

A. Current Status of the Market

Traditional customers of cellular service have been in the real-estate, construction, banking and financial industries and others that require mobile communications (eg. lawyers, doctors, etc.)

As of December, 1990, the US cellular services industry reached:

- 5.3 million subscribers representing 50.6% growth over 1989
- \$6.3 billion in cumulative capital investment
- \$4.55 billion in annual service revenues (an all-time record)
- \$1.8 billion annual investment in infrastructure representing 40% total annual revenue being reinvested in infrastructure
- Average monthly bill of \$80.90 (a decline)
- 6,025 sales agents operating across the US (an increase)

B. Sizing

Since the first operational MSA in 1983, cellular growth has been phenomenal. During 1985, 250,000 subscribers were added to the installed base putting the growth rate at 280%. That eventually leveled off to 62% per year by mid-1990, and current predictions put new subscriber growth at 20 to 25% per year. The decline in growth rate is due to the current economy and recession, and a lessening of demand by high-usage business customers. Companies are now concerned with the high cost of cellular service. Growth will remain strong but not at the rates previously experienced.

Dataquest estimates that cumulative revenues should reach \$7.6 billion by 1993, with the projected compound annual growth rate expected to increase to 22.6%. EMCI, Inc. estimates 10 million subscribers in 1993. Standard and Poors estimates 9.4 million subscribers in 1992 and 12.0 million in 1993. In the year 2000 they estimate:

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- 38.7 million subscribers
- \$29 billion in annual service revenues
- Average monthly bill of \$62.00 (a decline)

C. Constraints

1. Regulations

Cellular service operators must be licensed by the FCC which regulates the acquisition, construction and operation of cellular systems. As explained, all licenses had been granted by the end of 1990. While the FCC has a rulemaking process in operation to determine how to provide licenses for unserved areas, no procedures have yet been introduced. (See Modes of Entry.)

2. Physical Constraints

Physical constraints to the provision of cellular service exist. Due to popularity in certain major cities, particularly during rush hours, users are running into limited network capacity. Only one call can be placed per channel. This is related to limited available spectrum and it is not likely that the FCC will allocate additional frequencies. The introduction of digital technology will alleviate this situation somewhat as digital will allow three calls to use the same channel simultaneously. Currently all cellular phones are analog so it will be some time before users and cell operators switch from analog to digital technology.

3. Standards

With existing analog systems, a user can travel across the United States and make cellular calls from one area to the next because all systems operate the same by law and the cellular user equipment is compatible with the systems.

The future of digital cellular is moving to Time Division Multiple Access (TDMA) technology. TDMA encodes voice or data into a digital stream which is then transmitted over one channel, and 3 separate signals can be transmitted at the same time.

D. Geography/International Issues

There are no common equipment or operating standards on the

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international front, therefore it will be some time before compatible cellular is available around the world.

E. Players - Service Competition

The cellular industry can be divided into four segments:

1. Cell site, base station and switching equipment manufacturers:

Motorola, AT&T, Northern Telecom/General Electric, Ericsson, Astronet, NovAtel, NEC and Plexsys dominate this market. The focus of these vendors has been on networking larger regional systems, planning for the introduction of digital cellular systems to replace the current analog systems, and system construction in the rural markets and additional cell sites in metropolitan markets. In the long term, demand for current equipment is expected to decline and the major market will become replacement systems that will provide enhanced features at a lower operating cost.

2. Subscriber equipment manufacturers (cellular telephones)

This market is dominated by seven leading cellular brands which are carried by more than 50% of all cellular dealers. The domination by a few major suppliers limits the penetration of new manufacturers. Major suppliers include Motorola, NEC, Panasonic, Mitsubishi, NovAtel, Oki, and Audiovox.

3. Cellular services (system operators)

The cellular service industry already has undergone tremendous consolidation and is dominated by 12 companies which include McCaw Cellular (the largest), Pactel Cellular, BellSouth, Southwestern Bell, GTE Mobilenet/Contel, Bell Atlantic, NYNEX, LIN Broadcasting, Ameritech, US West New Vector and Centel.

4. Cellular service and subscriber equipment distributors, agents and retailers

In general, non-wireline carriers rely more on distributors and agents to promote their service on the basis of one-stop selling and for rapid market penetration, although this may vary from market to market. In the future, "power retailers" (regional and nationwide chains) are expected to be a major factor in increased sales. Both wireline and non-wireline carriers currently sell through retailers in most, if not all, major markets. Neither appear to have any real edge on negotiating distribution deals.

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F. Sources of Information

Associations and Experts:

Cellular Telecommunications Industry Association (CTIA)
1990 M ST, NW, Suite 610
Washington, DC 20036
202/785-0081

National Association of Cellular Agents (NACA)
1716 Woodhead St
Houston, TX 77019
713-522-5028
(Bob Hutchinson)

Telocator
2000 M ST, NW, Suite 230
Washington, DC 20036

William L. Ford
Ford Communications Inc.
17675 Foxborough Lane
Boca Raton, FL 33496
407-488-0570

Information Sources:

"A Competitive Assessment Of The US Cellular Radiotelephone Industry, 1988", Washington, D.C.: US Department of Commerce.

"Cellular Radio", Washington, D.C.: FCC Consumer Assistance & Small Business Division, Office of Public Affairs, March 1990.

"Cellular Subscribers Count Jumps Past 5 Million,"
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Keller, John J. "Cellular's Growth Spurt Is Put On Hold By Recession, Changing Demographics". Wall Street Journal, 29 January 1991.

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November 1990.

Sweeney, Dan. "Punching Up The Competitive Edge", Mobile
Communications Business, 14 April 1989.

"Telecommunications Opportunities in the 90's." Washington,
D.C.; seminar sponsored by Reed Smith Shaw & McClay Law
Firm, 13 March 1991.

US Industrial Outlook 1991. Washington, D.C. US Department of
Commerce.

Wehrwein, Peter. "Inside Cellular Resale". TELOCATOR, August
1986.

III. MARKET STRATEGY

A. Modes of Entry

There are four ways to offer cellular service:

1. Acquire a cellular license for an unserved area within an MSA or RSA. The FCC ruled that after 5 years, anyone can apply for areas not being served by existing carriers. A Notice of Proposed Rulemaking was issued in January 1990 and, as of yet, the FCC has not concluded rulemaking on how applications will be handled and licenses issued. At issue is how to identify the unserved areas and determine if they are economically viable.
2. Construction in an RSA. Not all RSA systems have been constructed. The FCC is considering allowing applications for areas where a construction permit has previously been granted, but has been revoked, or has expired without construction of a system by the 18 month deadline.
3. Challenge a license renewal. The FCC is considering rulemaking for renewal standards. Licensees have a 10-year term. There is a possibility that a challenger could file for a license if an incumbent were not offering service and performing as expected.
4. Purchase a service. Many of the non-wireline carriers have taken on tremendous debt to get their services constructed and

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operational. They are not yet profitable. From an acquisition standpoint, this can represent risky opportunity. One must believe strongly in the future potential of cellular and its ability to generate cash flow.

B. Timing Considerations

The major start-up and growth phase for the industry has probably been completed. The number of major acquisitions and mergers has abated since 1989. Prices for user equipment are declining, and so are revenues and usage statistics. The cellular market is expected to grow, but at a much slower rate. Anyone considering entry into this industry as an agent or reseller of cellular service should consider a focus on casual, individual users who may subscribe to the service for personal or convenience reasons and not necessarily for business. This is basically an untapped segment of the market, but is also the segment with the least usage per subscriber. While other modes of entry into the industry are possible, they are subject to rulemaking procedures which have not been determined.

C. Cost of Entry

The cost to build a service can be prohibitive depending on location. William Ford, an industry consultant, estimates that the cost to build a cell could range from \$3,000 to \$1 million depending on location. In a smaller area, a single cell system could cost \$750,000 to construct plus the cost of equipment and operational services such as customer service to handle subscriber calls.

D. Critical Factors for Success

1. Market growth.
2. Limited impact of Personal Network Communications (PCN).
3. Continued decline in the price of cellular telephones and cellular service.

IV. Opportunities for MBEs

Because of the enormous resources required to enter either the equipment manufacturing area or the cellular service market, the best opportunities for small MBE's without extensive capitalization in cellular is as equipment distributors for the new digital cellular (telephone) equipment or agents marketing cellular service for existing systems.

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MARKET SEGMENT ANALYSIS

MOBILE RADIO AND SPECIALIZED MOBILE RADIO (SMR)

I. MARKET DEFINITION

Mobile radio is two way, point-to-point communication using radio signals between a fixed location and a mobile vehicle.

Of the wireless technologies, mobile radio has the longest history of usage, especially within the business community. The mobile radio opened up totally new horizons for businesses that desired contact with people or equipment on-the-move. Private fleet owners (trucks, cars, and cabs) were the first to use private radio networks. Public radio networks were then established to make this service available to smaller businesses. Mobile radio has not penetrated the consumer market.

The popularity of mobile radio has been driven by:

- Declining equipment prices
- Relative ease of installation and implementation (private networks)
- Flexibility, utility, and availability (private networks can be developed where and when needed)
- Need for wireless data solutions
- Less expensive, more efficient service providers.

Mobile Radio will come under heavy competitive pressure from cellular and Mobile Satellite Services (MSS) especially as businesses require more interactive communications and data transmission. MSS involves the use of a fixed location dispatch via satellite to specially equipped vehicles.

Mobile radio historically has been successful in the following markets:

- Public safety
- Field communications for local, state and federal agencies

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- Utilities
- Local trucking and delivery firms
- Taxi services
- Transit systems
- Construction companies

The mobile radio market place has evolved into several application areas:

- Mobile voice
- Mobile data
- Specialized mobile radio (SMR)
- Private mobile radio

Private mobile radio systems comprise the greatest use of mobile radio. The benefits of private mobile radio are:

- No usage fees
- No rate increases (to budget for)
- Increasing asset value of owning radio bandwidth; (private mobile radio systems must be licensed by the FCC)

II. MARKET ENVIRONMENT

A. Current Status of Market

The demand for ubiquitous wireless communications has created a new market of mobile voice/data service providers. The lack of frequency has ignited a wave of acquisition of smaller mobile radio companies by those companies seeking to build a regional and/or nationwide mobile radio network.

SMR service is primarily used for data applications. Most transmissions are relatively short messages. SMR is a trunked system which allows the user to share the numerous channels over a single transmission link. Trunking uses computer technology to

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automatically assign open channels to two-way radio users and queue up intended transmissions when no channels are available. The principle benefit of trunking is improved efficient use of spectrum. In conventional mobile systems users must select their channel manually.

There are three implementations of mobile radio, one voice and two data:

- Half-duplex voice
- Specialized Mobile Radio (SMR)
- Packet Radio

These systems typically operate at the 150, 450, or 800/900 MHz frequencies.

1. Half-duplex Voice

Mobile radio operates in half-duplex mode (push-to-talk). Transmission can occur in either direction, but only in one direction at a time. Traditional mobile radio networks function like a party line and users must time their transmission so as not to interfere with other users on the same channel. Some mobile radio systems, to reduce this interference, divide the channel into subchannels through the use of frequency division multiplexing (FDM) with each user assigned to a subchannel.

Mobile communications have been dominated by private half-duplex radio systems.

- Police departments
- Corporations, especially those with field operations-related activities, i.e. oil/gas, construction, etc.
- Taxi services
- Dispatch/delivery services, e.g. UPS, Federal Express
- Armed Forces

Although mobile voice systems are still the most popular their inefficient use of scarce spectrum has driven the demand for mobile data services. Voice communication for many repetitive functions such as dispatching and status reports is inefficient, with as much as 60-70% of a typical voice conversation consisting of silence.

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2. Specialized Mobile Radio

Specialized Mobile Radio (SMR) provides mobile data service of relatively short messages and can be offered commercially. In an SMR system, the base station equipment supplier is the licensee of the transmitters. Users have access to the multiple channels of the network rather than the limited number of channels of a private mobile radio network. Sharing is accomplished on a first served basis. When a user wants to initiate a call, he or she activates the push-to-talk button on the handset. Assuming the portable unit (and dispatcher or other portable unit) is tuned to available channels, a communication path is established. If no channels are available which both the sender and receiver can use, the call cannot be completed and the call initiator must wait for another opportunity to try again. Although current use is predominantly voice communications, a number of data applications are possible including messaging, data base access, order entry, and vehicle location.

SMR provides the best opportunity for the mobile radio industry. SMR systems can serve a wide variety of end users including corporate, public, special emergency or industrial, and a variety of mobile communication requirements (e.g. paging, dispatch, telephone interconnection). Because an SMR system is shared by many users (like a service bureau), costs are spread over a larger base making service use affordable to small businesses and individuals. SMRs are licensed by the FCC as private land mobile radio service. Most SMRs operate in and around 800 MHz.

3. Packet Radio

Packet radio involves the use of packet data transmission for radio. Two of the largest private packet radio networks are those of IBM field service and Federal Express.

B. Sizing

The mobile radio market is mature. High growth is not projected for this market. The revenue projection and CAGR (compound annual growth rate) for private and public mobile radio can be seen in the following tables.

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Table 1
Mobile Radio Worldwide Market Projections

	1990	1991	1995	CAGR
Private Mobile Radio	\$2.1B	\$1.6B	\$1.4B	-7.8%
Public Mobile Radio	\$2.3B	\$2.4B	\$2.5B	1.7%

Source Gartner Group

Table 2
Mobile Radio U.S. Market Projections

	1990	1991	1995	CAGR
Private Mobile Radio	\$820M	\$500M	\$260M	-20.5%
Public Mobile Radio	\$1.3B	\$1.5B	\$8500M	-8.2%

Source Gartner Group

C. Constraints

1. **Transmission quality**
Mobile radio systems are susceptible to noise from a variety of environmental conditions including weather, power lines, electrical motors and other frequency emitting devices.
2. **Security**
A common problem with wireless communications is that signals can be overheard by common consumer receivers (scanners).
3. **Coverage**
Mobile radio systems are limited to the communication range of the transmitter and by the number of transmitters in the area of travel. The same level of coverage achieved by a mobile satellite service (MSS) can not be practically, or economically, achieved by mobile radio.
4. **Channel availability/frequency congestion/interface**
In densely populated areas, private mobile systems are restricted to a finite number of channels which can not be shared once all channels are in use.

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5. Incompatible air interface protocols
Lack of standards preclude cross-use of (different) systems and make integration of SMRs unlikely.
6. Speed Limitations
Mobile data is limited to low speed communications (1200 bps, bits per second), although the new, more efficient error connection techniques may be able to support 8 kbps(kilo bits per second) or more in the near future.
7. Cost of nationwide coverage
The cost of implementing a nationwide mobile radio network could reach \$3 billion (as compared to an MSS system estimated at \$1 billion).
8. Cost of Switchover for the private network user
Users of private networks considering using SMRs will be faced with the cost of replacing their receivers with those able to access the SMR. Furthermore, they will be paying for a service (network access charges) which had previously been free under private networks.

D. Geographical/International Issues

Over five million vehicles are equipped with mobile radios in the U.S. Mobile radio has its greatest market penetration (3-4% of trucking markets) in North America, but has not realized significant market penetration in the rest of the world (less than 1% overall).

E. Players

Mobile radio market is dominated by a few vendors including Motorola, E.F. Johnson, General Electric, and Ericsson. Some of the leading mobile radio services include:

1. Motorola Coverage Plus
 - Voice/data competitor to Mobil Satellite Services (MSS) truck tracking/communications system,
 - Nationwide service.
2. Advanced Radio Data Information Service (Ardis)
 - Joint venture between Motorola and IBM, formed in 1/90,

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- First company to provide point-to-point and host-to-terminal transmission service,
 - After beta testing, it will serve over 8,000 major metro areas in 50 states,
 - Uses facilities of IBM's private radio data systems and Motorola's shared radio data system.
3. Fleet Call
- Has been acquiring various dispatch operations around the country in order to provide a voice/data service alternative to cellular.
 - The company is preparing to upgrade the dispatch service in order to provide enhanced service. Fleet Call is proposing to convert its stand-alone SMR systems in Chicago, Dallas, Houston, Los Angeles, New York, and San Francisco from analog into integrated digital systems which would provide 15 times the current capacity.
 - Fleet Call spent \$250 million to acquire 1600 dispatch channels in those cities.
4. American Mobile Data Communications
- 2-way shared-access mobile data network, known as Mobitex.
 - Will be a \$200 million nationwide network.
 - Will use digital packet switching radio gear on 200 channels in the 935-940 MHz band and will lease intercity network links from third party supplier(s).
 - Mobitex service is available in Sweden and several systems are planned for Canada (for Cantel).
5. Other Motorola Ventures
- Localized version of Coverage Plus for public works departments.
 - With BCD Mobile Communications of Canada, Motorola is building a combined mobile data terminal and alphanumeric paging network called the Mobidata Communications Network.

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Due to the nature of the service mobile radio provides, the competition includes many companies that are not directly in the mobile radio business. Mobile radio is directly competitive with paging (for emergency, remote access), cellular (for dispatch, customer service, remote access, some data services), and mobile satellite service (MSS) (for vehicle tracking, voice and data communications). The strongest competitor for SMRs will come from MSS. There will be a need to clearly differentiate the service from both MSS and cellular, as the latter develops its own data capabilities.

F. Sources of Information

Gartner Group Consulting: Gartner Group has 18 research services provided to its clients and subscribers. These services cover a wide variety of technology segments. Information for this project was extracted from the following services - Enterprise Network Strategies, Local Area Communications, Office Information Systems, and Personal Computing Services. Each service publishes bi-monthly research notes that cover specific activities, trends or projections in their market. They publish quarterly strategic analysis reports which cover key issues in each market place. Last, they provide an annual update on the market and the market directions.

"Specialized Mobile Radio", Washington, D.C.: FCC Consumer Assistance & Small Business Division, Office of Public Affairs, February 1989.

"Telecommunications Opportunities in the 90's." Washington, D.C.; seminar sponsored by Reed Smith Shaw & McClay Law Firm, 13 March 1991.

III. MARKET STRATEGY

A. Modes of Entry

Limitations of voice radio, has opened up opportunities for SMR. SMR services are licensed by the FCC to operate as a provider of network service to subscribers. Anyone can apply for a license in areas where the 800/900 MHz frequency is available and implement an SMR service.

B. Timing Considerations

The FCC is currently licensing both 800 and 900 MHz SMR systems

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where the frequency is available and has proposed to set aside channels for national licensing.

C. Cost of Entry

A metropolitan-based private mobile radio system for a small number of terminals may cost around \$70,000 (exclusive of maintenance), of which, \$40,000 is required for the radio tower. After this initial capital investment, air time is "free".

Estimated construction costs for a commercial SMR system, operating at 800 MHz with 5 channels, range between \$100,000 and \$150,000.

D. Critical Factors for Success

The following factors need to be assessed and addressed by any MBE considering opportunities in this industry segment:

- The future use-growth of mobile radio will be driven by data and voice/data applications; voice-only use will stagnate and even decline as it is replaced by cellular or Personal Communication Networks (PCNs).
- Integration of mobile data MIS will be required in order to achieve optimal benefit from its advantages.
- The Regional Bell Operating Companies are unlikely to get into the SMR market.
- Incompatible signaling systems make the integration of SMR's unlikely.
- Many users faced with replacing their two-way radios to access an SMR may decide not to use the system.
- SMR systems do not provide the degree of national coverage possible in a MSS system.

IV. OPPORTUNITIES FOR MBES

While the mobile radio market is mature with limited growth, Special Mobile Radio as a commercial service provides a way for more efficient use of spectrum and addresses the requirement for mobile data transmission, although it does face competition from other newer technologies. MBES interested in this technology can consider becoming licensed SMR operators and target the consumer market and small businesses requiring two-way mobile communications of voice and data.

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MARKET SEGMENT ANALYSIS

RADIO PAGING

I. MARKET DEFINITION

Radio paging is one-way mobile communications service, which in typical operation begins with a dialed telephone call to a paging service operator, usually a Regional Bell Telephone Operating Company (RBOC), Radio Common Carrier (RCC) or Private Carrier Paging (PCP). The paging operator next sends a special signal to a radio transmitter which broadcasts the signal within a specific local or regional geographic area or nationwide. Specially designed portable radio receivers, called pagers or beepers, pick up the signal if they are properly tuned to that radio frequency and generate an audible, light or vibration signal, depending on the type of pager.

RBOCs and RCCs are considered public common carriers and provide paging services to general business and consumers. Private carriers provide service to specific organizations such as hospitals and shopping malls.

There are four basic types of paging service available today:

- **TONE ONLY:** The subscriber receives only a signal to contact a prearranged telephone number to receive the message
- **TONE & VOICE:** The subscriber receives a signal and/or audio voice message
- **TONE & DIGITAL/NUMERIC DISPLAY:**
The subscriber receives a digital signal and/or numeric message (since 1982)
- **TONE & DIGITAL/ALPHANUMERIC DISPLAY:**
The subscriber receives a digital signal and/or alphanumeric message (since 1984)

TONE ONLY and TONE & VOICE services may or may not be offered along with a dispatch or answering service.

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II. MARKET ENVIRONMENT

A. Current Status of Market

As of December, 1989, the radio paging industry reached 8.1 million subscribers (all carriers). Approximately 75% to 85% of all pagers in service are served by 10% of the paging firms. RCCs collectively serve about 60% of the paging market, PCPs serve another 15%, and telephone companies about 25%.

In recent years, the industry has undergone significant consolidation. In particular, the RBOCs have aggressively moved into paging using their extensive capital resources to acquire small, medium and large individual properties. Independent RCCs have also acquired smaller firms or entered into joint ventures to increase coverage. Other large, well-financed participants from broadcasting, cable, publishing, long distance, and venture capital business have entered through major acquisitions. Despite this trend, hundreds of small operators with less than 1,000 pagers in service and hundreds more mid-sized operators with a few thousand pagers in service survive.

A typical market consists of:

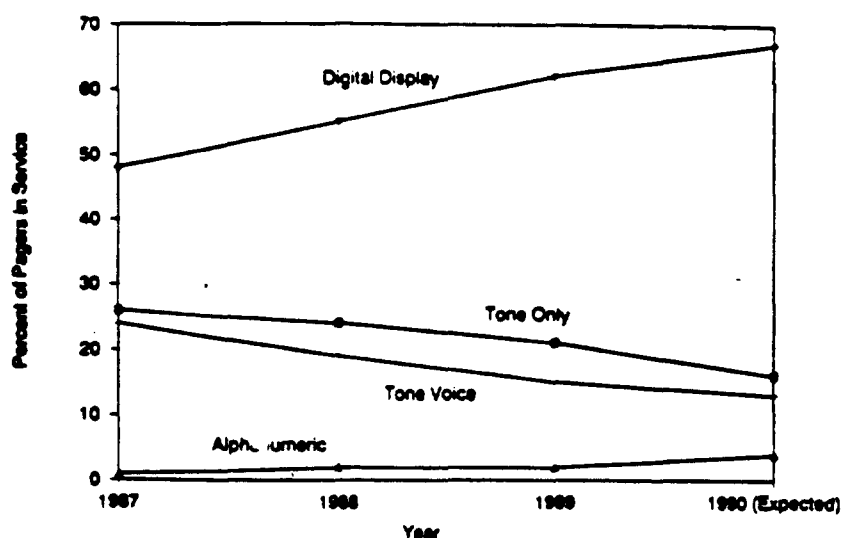
- Two or three strong local carriers affiliated with major national organizations, including new nationwide paging service providers
- Telephone company paging operators
- One or two local independent RCCs that have built and maintained strong positions in the local market

With the exception of the nationwide operators, most operators serve markets within a 100 mile radius.

Digital/Numeric display pagers dominate the overall market because of the increased capacity of subscribers per channel. Tone Only and Tone & Voice pagers have declined significantly in usage. However, Tone & Voice still account for more than half the pagers in service for small operations in small markets primarily because of the relatively abundant availability of radio spectrum (although the trend is now moving towards digital/numeric). Digital/Alphanumeric paging has remained an insignificant factor because of the difficulties involved with data entry and display. (See Figure 1.)

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Figure 1
Distribution of Pagers in Service by Type, 1987-1990
(Percent of Pagers in Service)



Source: EMCi, Inc., based on Telocator/EMCI paging surveys,
December 1988, June 1989, December 1990.

The following developments also affect the paging market:

Microcomputer technology has allowed base station paging terminals to become fully automated.

Digital paging has allowed increased capacity over existing channels.

Liquid crystal display (LCD) technology has allowed the development of numeric and alphanumeric display pagers, along with wristwatch pagers.

The digital/alphanumeric display pager is being improved, especially in terminal entry techniques. This, along with the growth of data services and value added services (e.g. financial, sports, weather, and news) should promote growth in the 1990s.

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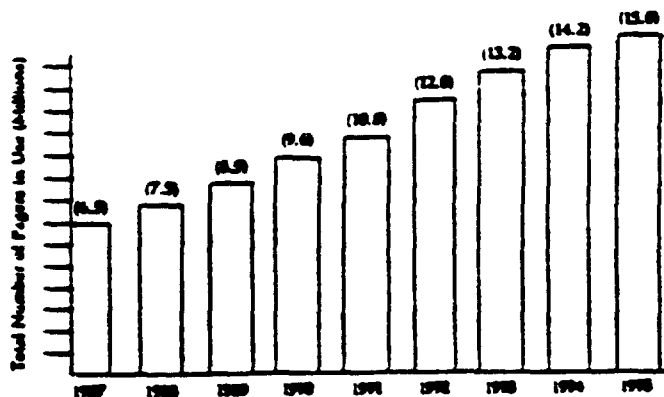
In 1990, the wristwatch pager was introduced for certain frequencies. However, its viability in the market is still unclear (i.e., is it a fad or a real tool?)

B. Sizing

According to a January, 1990 study conducted by EMCI, Inc. and Telocator, the paging industry reached 8.1 million subscribers (all carriers) in December 1989. This represents a 17% increase from 1988. EMCI projected that 9.3 million pagers would be in service in 1990, and the +10 million mark reached some time in 1991.

Arthur D. Little projects the paging market will grow 8-15% a year from 1987 to 1995. They estimated 8.5 million pagers would be in service in 1989 and 15 million in 1995. (See Figure 2). They estimate that each subscriber generates an average revenue of about \$235 per year (in 1988) and expect competitive pressures to reduce this by 3%-5% a year.

Figure 2
Total U.S. Radio Paging and Messaging Market



Source: Arthur D. Little, estimates

Motorola believes the industry will continue to expand at a 19% average annual growth rate with subscribers in service reaching the 21 million market by 1993.

A Frost and Sullivan study done during 1989, projected paging revenues to be \$1.8 billion in 1989 (versus \$1.6 billion in 1988) and estimated 1990 revenues at \$1.9 billion. (These figures are considered conservative by Telelocator, industry trade association, but no actual revenue numbers are available.)

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The market for paging is the U.S. population as a whole, although current efforts have been directed at developing specific segments (e.g., medical, construction, and service industries) and at gaining market share within these segments. Now under-penetrated markets are being addressed including professional services, sales and sales management, auto repair, engineering, and real estate. In addition, operators are now beginning to sell the concept of paging allowing greater mobility versus the concept of the electronic leash.

The general sentiment within the industry is that the consumer market for paging is several years away because of low awareness and lack of suitable distribution channels. More operators are expanding the market by offering packages with complementary services such as voicemail, cellular, 800 service, and data services.

C. Constraints

The only true restraint to entering the paging operation service is frequency allocation.

In the 1970s, the FCC limited paging services to a total of 27 lowband (35-40 MHz) channels and the VHF and UHF bands (150-450 MHz). These channels were split between the local telephone operating company and RCCs. In the 1980s, the FCC allocated more channels for a total of 120. The FCC also allows the use of paging as a "secondary service" on formerly dedicated mobile telephone frequencies. (See Table 3.)

In addition to these allocations, the FCC has allocated additional radio channels to PCPs and has authorized radio broadcasters to use subcarrier radiations at the fringes of the FM broadcast for transmitting other-than-broadcast types of communications traffic, including paging.

Despite the allocation of these channels, suitable, available, unlicensed frequencies are hard to come by in large and medium sized markets.

- **LOWBAND (35-43 MHz):** Most have been committed to established carriers in major markets, some are still available to new operators in mid-sized and rural markets. Problems in operating coverage from skipping signals over long distances and from shielding and reflection by tall buildings, hills or mountains; inexpensive equipment, good geographic coverage in rural areas.

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- VHF (150 MHz): Virtually all have been committed in major markets. Most desirable by offering good geographic coverage, above average building penetration.
- UHF (450 MHz): Most have been committed to established carriers in major markets. Second most desirable, less geographic coverage, good building penetration.
- 900 MHz: Most available. Good building penetration, diminished geographic coverage, expensive antennas and equipment that require more engineering.

In general, only one operator may use a given frequency within a 150 mile line of sight, subject to coordination by NABER (National Association of Business Education Radio).

Table 3
U.S. Radio Paging Channel Availability, 1988

Band	Frequencies (MHz)		Number of Channels	
	Paging Channels			
Low VHF	35.20	-	35.66	16
Low VHF	43.20	-	43.66	16
High VHF	152.03	-	158.70	22
UHF	454.025	-	454.680	26
900 MHz	931.0125	-	931.9675	40
	Mobile Telephone (MTS) Channels Available for Paging			
High VHF	152.03	-	152.21	7
	152.51	-	152.51	11
UHF	454.025	-	454.350	14
	454.375	-	454.650	12

Source: Arthur D. Little, Inc. estimates.

D. Geographical/International Issues

See CONSTRAINTS in paragraph I.C.

E. Players/Competition

Top U.S. telephone company radio paging operators:

Southwestern Bell
Pacific Telesis
US West

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Bell Atlantic
Ameritech
Telephone and Data Systems
Nynex
Bell South/Mobile Communications Corp of America
GTE

Top private U.S. radio paging operators:

Graphic Scanning (Plainview, NY)
Paging Network Inc. (Dallas, TX)
McCaw Communications (Kirkland, WA)
USA Mobile Communications (Cincinnati, OH)
Crico Communications CORP (Rockville, MD)
Metrocall (Alexandria, VA)
Ram Broadcasting (Avenel, NJ)
Communications Properties (Greenville, SC)
Interlink Communications Co. (Englewood, CO)

Nationwide paging networks:

Cue Paging Corporation
Network USA
Skytel
Metrocast
Telefind Corporation
National Satellite Paging

Competition:

While most operators consider paging and cellular as complementary services which are often packaged together, approximately a third of all operators feel that the new class of lightweight cellular pocket telephones are competitive.

F. Sources of Information

Associations and Experts:

National Association of Business Educational Radio (NABER)
1501 Duke Street
Alexandria, VA 22314
703/739-0300

TELOCATOR NETWORK OF AMERICA
2000 M Street
Washington, DC 20036
202/467-4770

Telecommunications Study:
MBE Opportunities

EMCI, INC.
1130 Connecticut Avenue, NW
Suite 700
Washington, DC 20036
202/331-7272

STUART CRUMP, Editor of CELLULAR SALES AND MARKETING newsletter,
author of THE PORTABLE OFFICE
Herndon, VA
703/787-4647
703/742-9696

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